

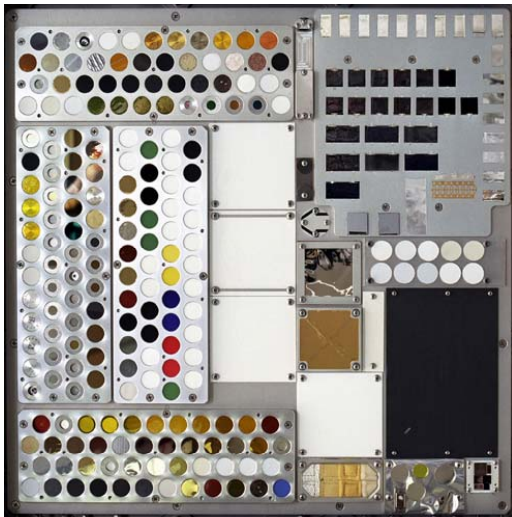
Estimated Environmental Exposures for MISSE-3 and MISSE-4

**Miria M. Finckenor
NASA / Marshall Space Flight Center**

**Dr. Gary Pippin
The Boeing Company**

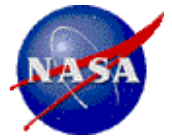
**William H. Kinard
NASA / Langley Research Center**

June 2008

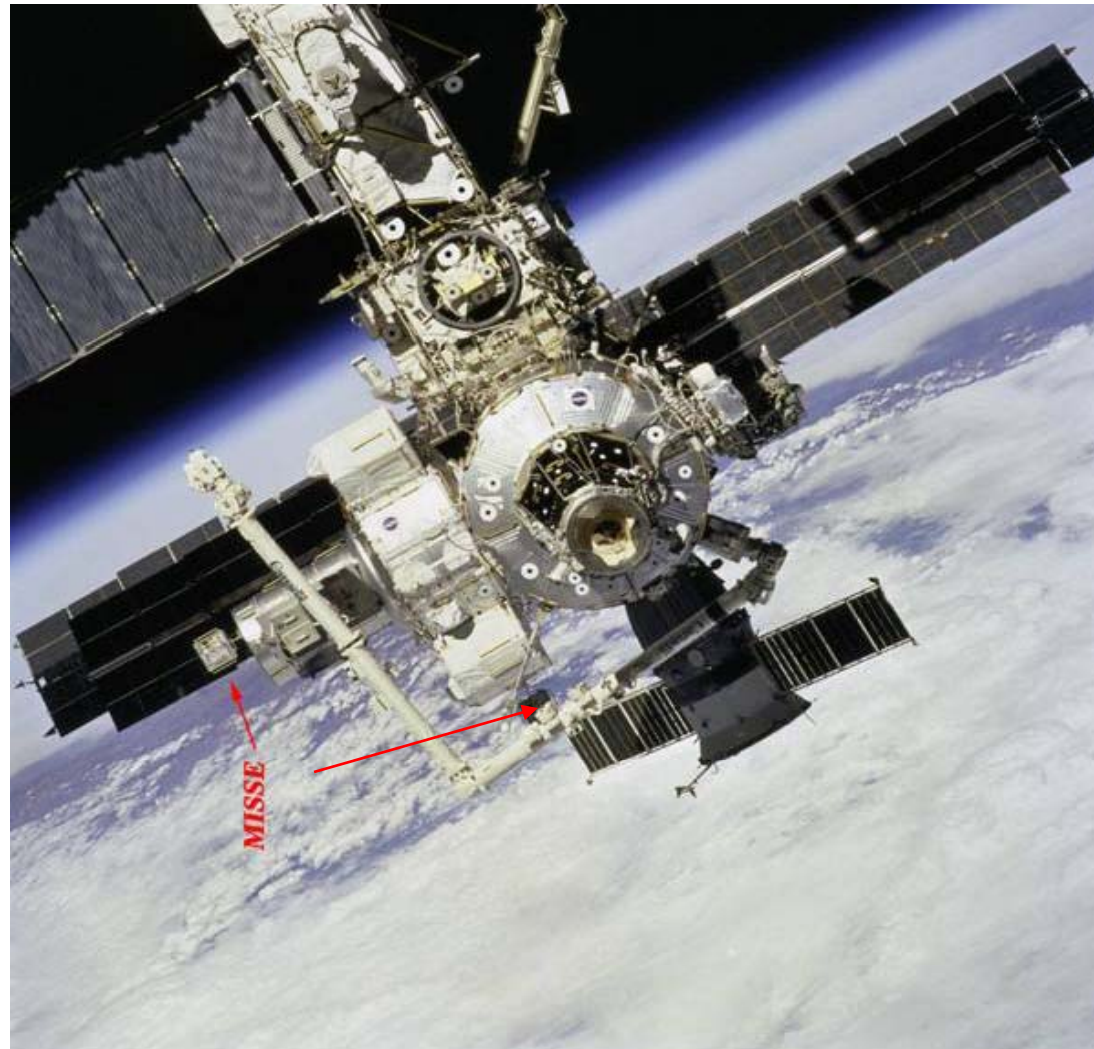


MISSE-3 and -4

- Originally planned for 3 year exposure
- Changed to 1 year exposure after MISSE-1 and -2 were in space for 4 years
- Located on Quest Airlock
 - Deployed August 3, 2006
 - Retrieved August 18, 2007
- ISS in mostly LVLH XVV attitude
(Local vertical local horizontal, X-axis in velocity vector)



Locations of MISSE-3 and MISSE-4



MISSE-3 and -4 Environmental Exposure

Low Earth Orbit Space Environment

- Atomic Oxygen
- Ultraviolet Radiation
- Particulate Radiation
- Thermal Cycling
- Vacuum
- Plasma
- Meteoroid / Space Debris Impact

Also contamination associated with proximity to
an active space station

MISSE-3 AO-UV SIDE



Slight UV
increases

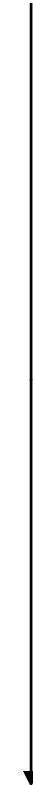


Solar UV fairly uniform (~1,695 to 1,750 ESH)

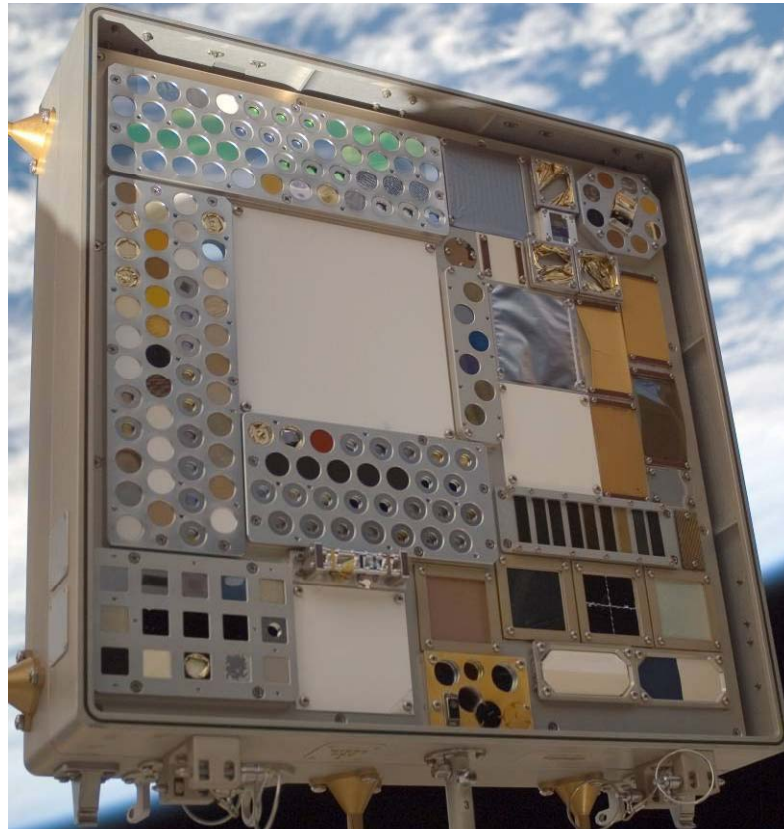


AO fluence

Decrease



MISSE-3 UV SIDE



Solar UV
increase

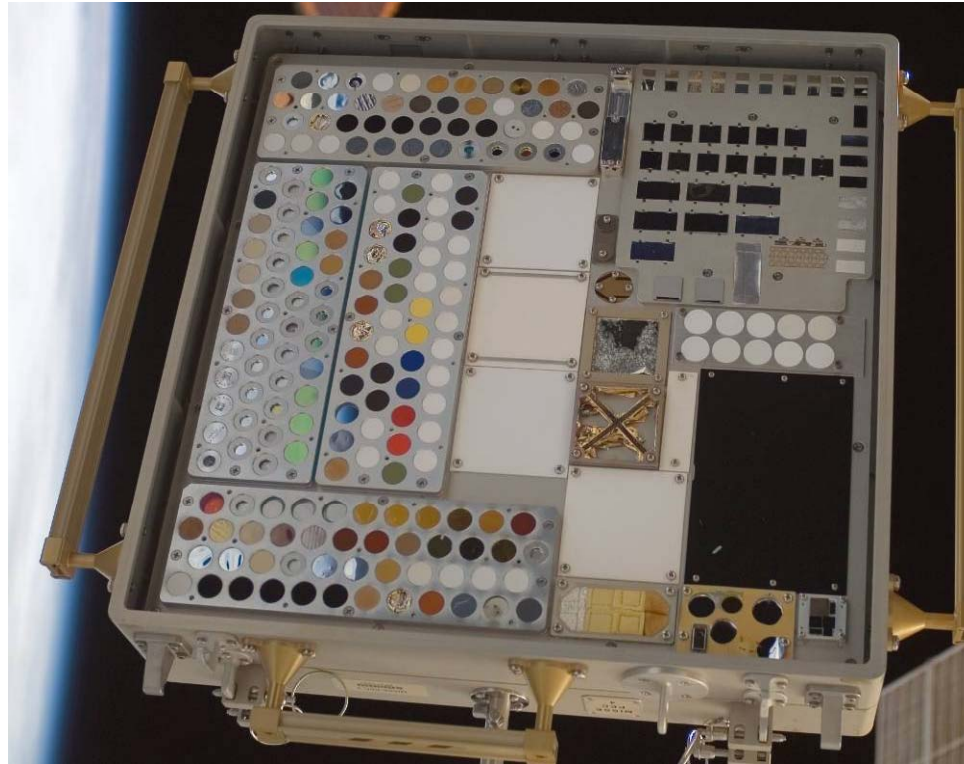
**Solar UV exposure on wake side much less than ram side
655 to 790 ESH**

MISSE-4 AO-UV SIDE



AO fluence

Increase

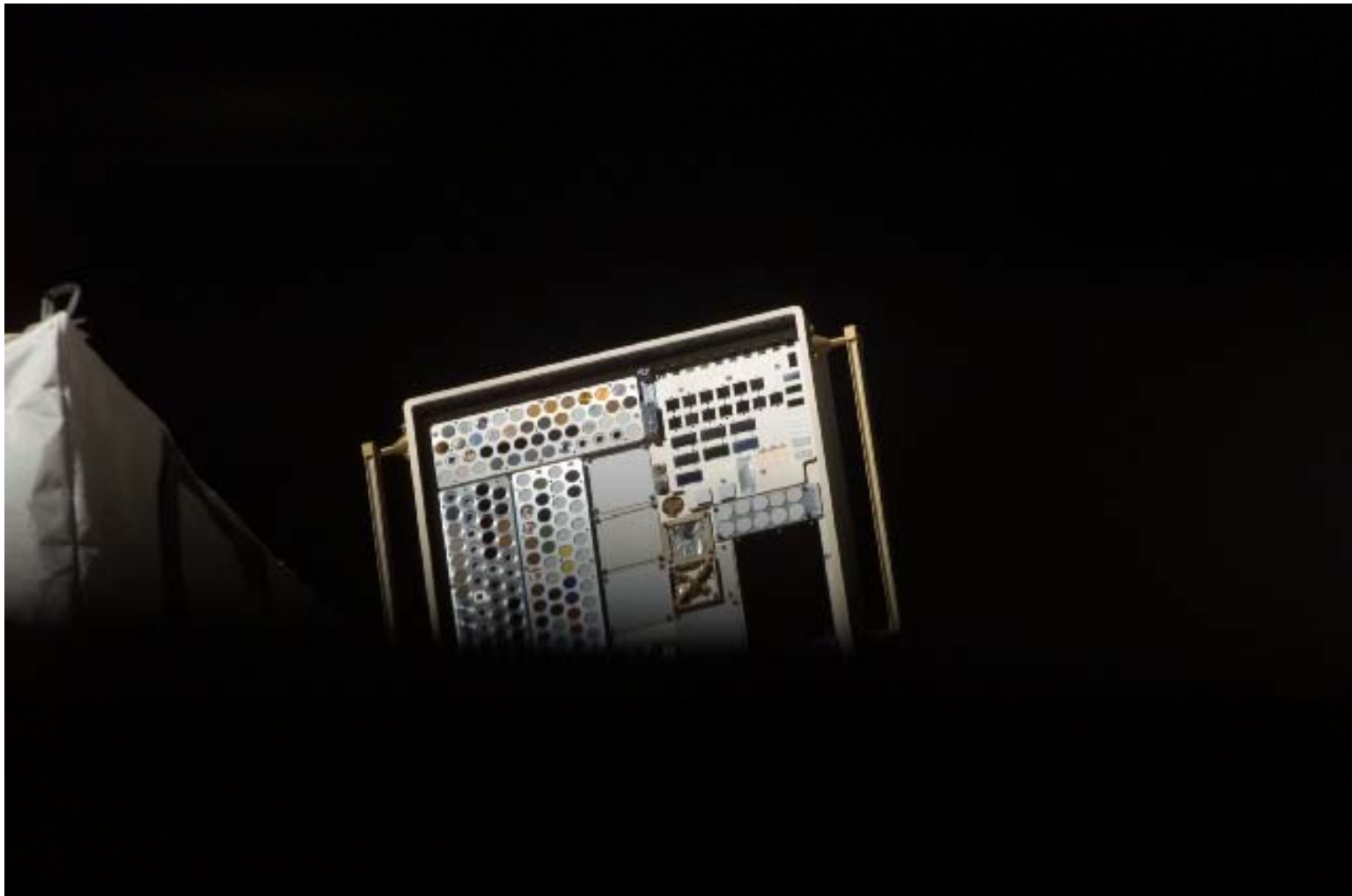
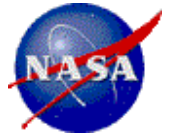


Decrease

Increase

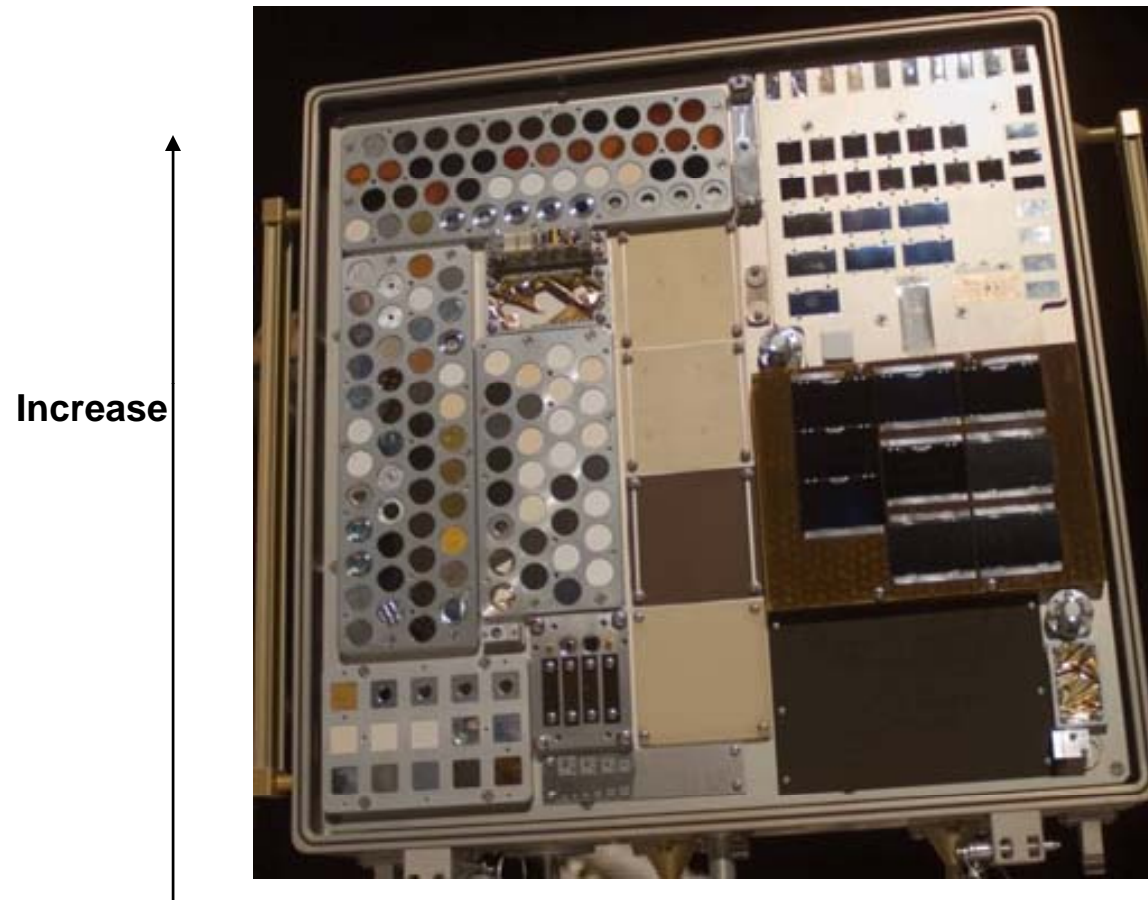
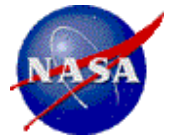
Solar UV varied from 1,200 to 1,590 ESH

Shadowing of MISSE



S118E06788

MISSE-4 UV SIDE



Solar UV varied from 825 to 995 ESH

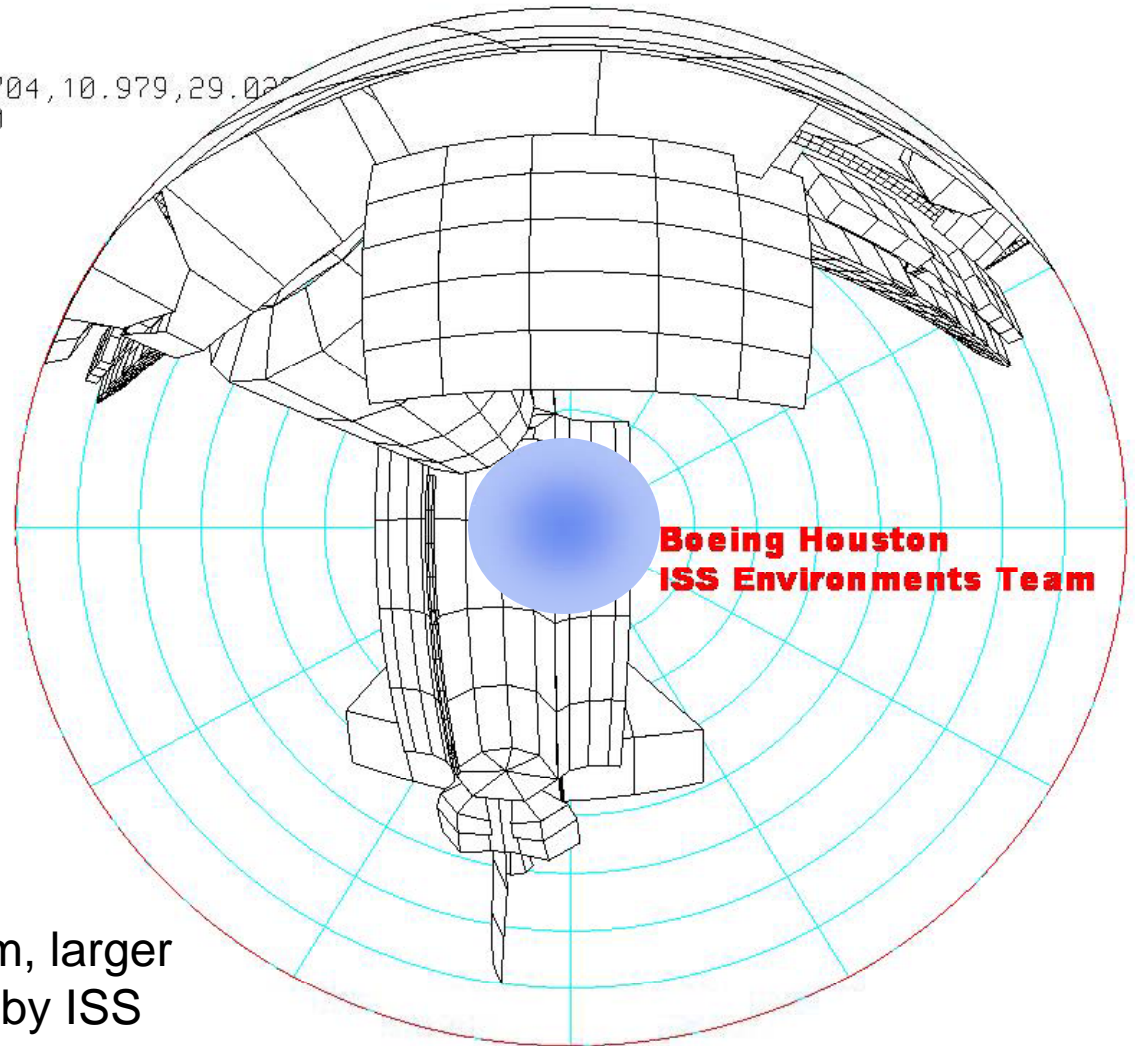
ISS ram view from MISSE-1 (Similar for MISSE-3)



Location : -14.704, 10.979, 29.028
Direction : 1, 0, 0



Representation
of extent
of AO beam,
+/- 15° due to
thermal velocity
spread

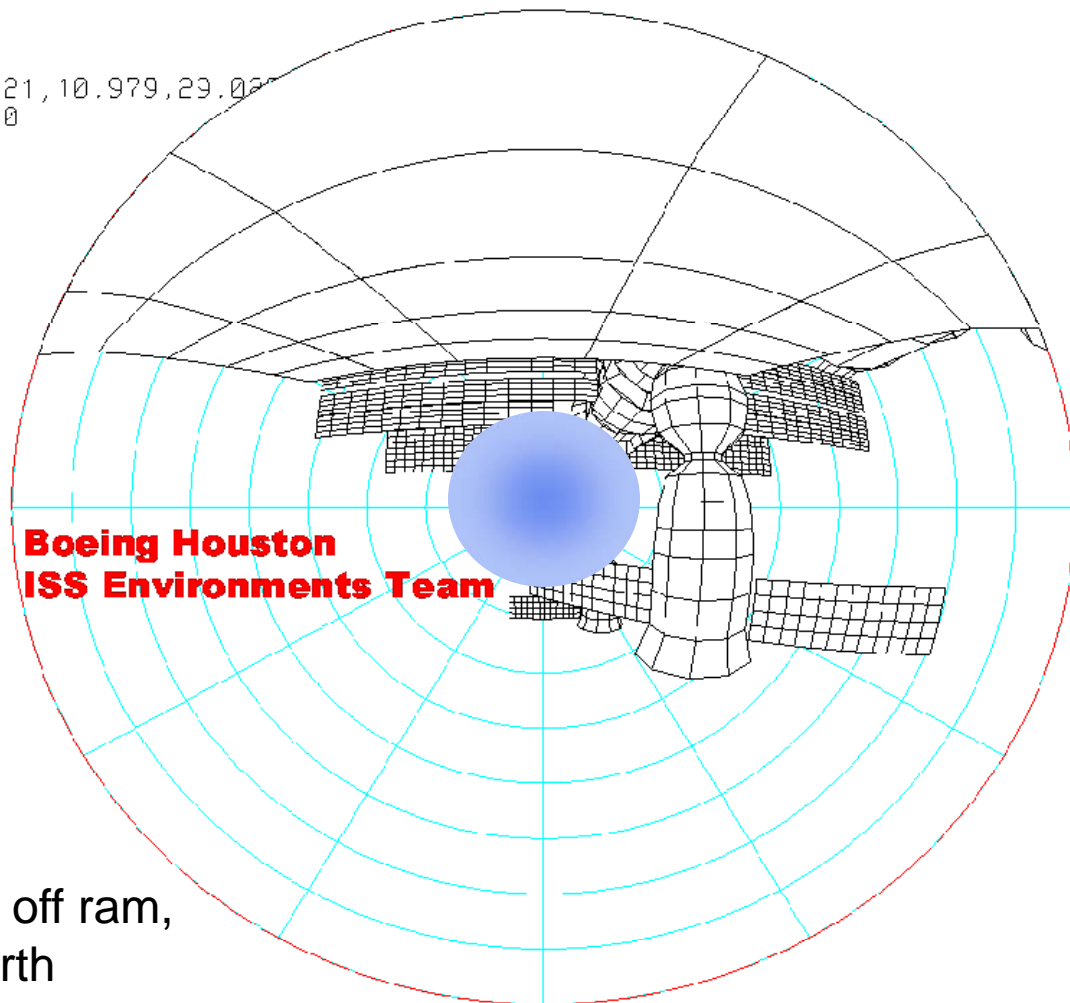


MISSE-3 angled up, 30° off ram, larger
fraction of unit sphere blocked by ISS

ISS wake view from MISSE-1 (Similar for MISSE-3)



Location : -15.121,10.979,29.025
Direction : -1,0,0



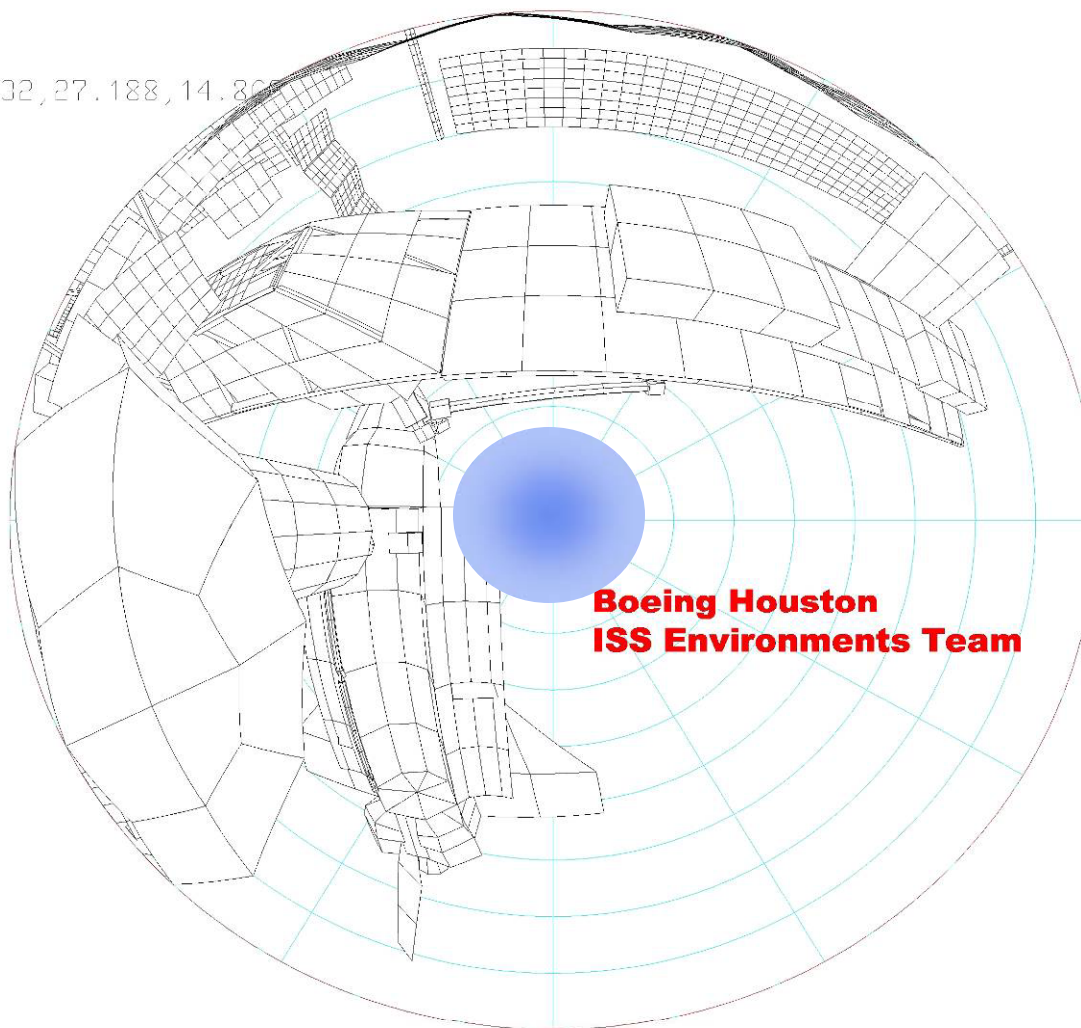
MISSE-3 angled down, 30° off ram,
increased view factor to Earth

ISS ram view from MISSE-2 (Similar for MISSE-4)



BOEING

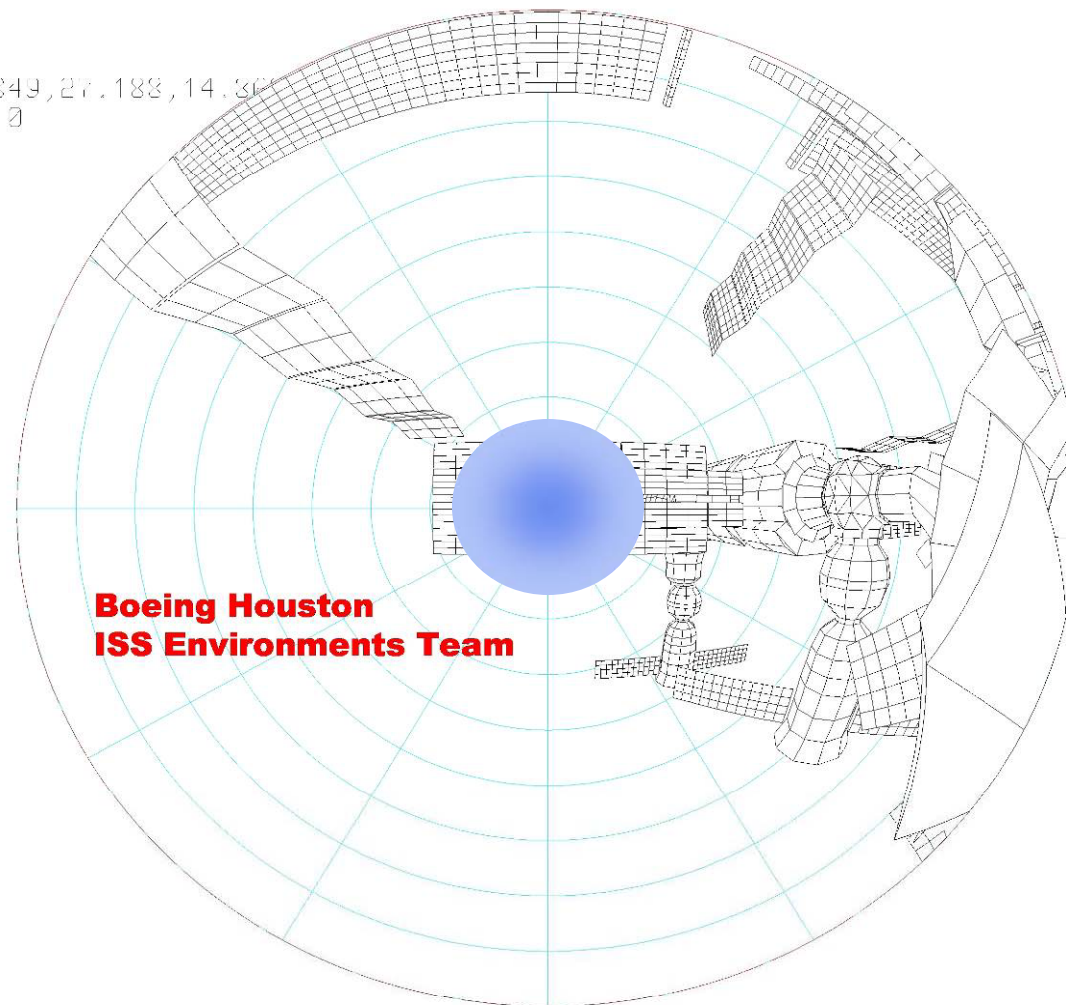
Location : -15.432, 27.188, 14.808
Direction : 1, 0, 0



ISS wake view from MISSE-2 (Similar for MISSE-4)



Location : -15.849,27.188,14.365
Direction : -1,0,0



**Boeing Houston
ISS Environments Team**



Atomic Oxygen Fluences for MISSE 3 & 4

	Calculated (x 10 ²¹ atoms/cm ²)	Measured (x 10 ²¹ atoms/cm ²)
MISSE-3 Ram	1.50	1.2 – 1.3
MISSE-3 Wake	0.294	0.19
MISSE-4 Ram	1.82	2.06 2.14*
MISSE-4 Wake	0.364	N/A

Both mass loss and thickness loss were measured.

Periodic orientation changes of ISS lowered exposure to specimens on MISSE-3 & MISSE-4

***Glenn Research Center data , courtesy of Kim de Groh and Sharon Miller**



Determination of solar UV exposure levels

MISSE-3 & MISSE-4

“Monte Carlo” model used to estimate ESH on each surface

Divided each surface into 2” x 2” areas

Model accounts for range of solar beta angles

Exposure period of ~1 year

Nominal Exposure		Range of ESH (total)	Earth-reflected ESH
MISSE-3	AO-UV	1700	120
MISSE-3	UV	700	250
MISSE-4	AO-UV	1200-1600	75
MISSE-4	UV	900	300

MISSE-3 & MISSE-4 solar exposure estimates do not account for shielding by the Space Shuttle

Radiation dosimetry



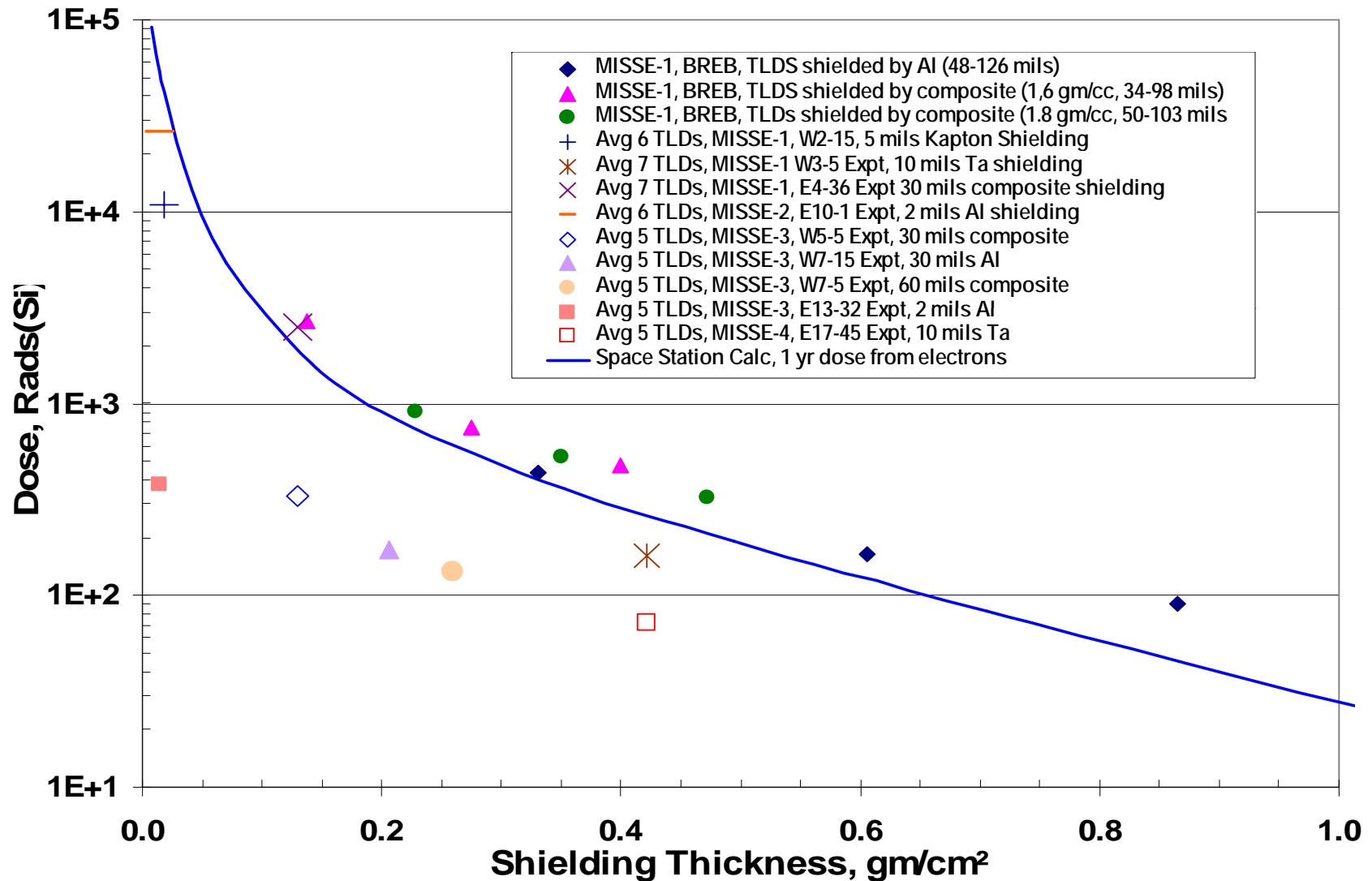
Boeing Dosimetry results from MISSE-1 through MISSE-4 are based on TLD measurements, with a variety of materials used for shielding.

Data was compared to earlier Russian experiment.

Shielding by ISS structure and Earth has significant influence on results – as more hardware has been added, the measured dose has decreased.

Loral radiation dose experiment results were presented at 2007 SAMPE Conference.

MISSE-1 through MISSE-4 TLD Readings, up to 4 yrs at ISS, Dose vs Shield Thickness



Thermal conditions

MISSE-3 and MISSE-4 LaRC data logger measurements of temperature show thermal cycling $\sim -40^{\circ}\text{C}$ to $+40^{\circ}\text{C}$, with excursions up to $+60^{\circ}\text{C}$.

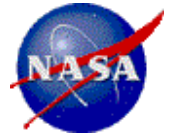
Vacuum

10^{-6} torr or less

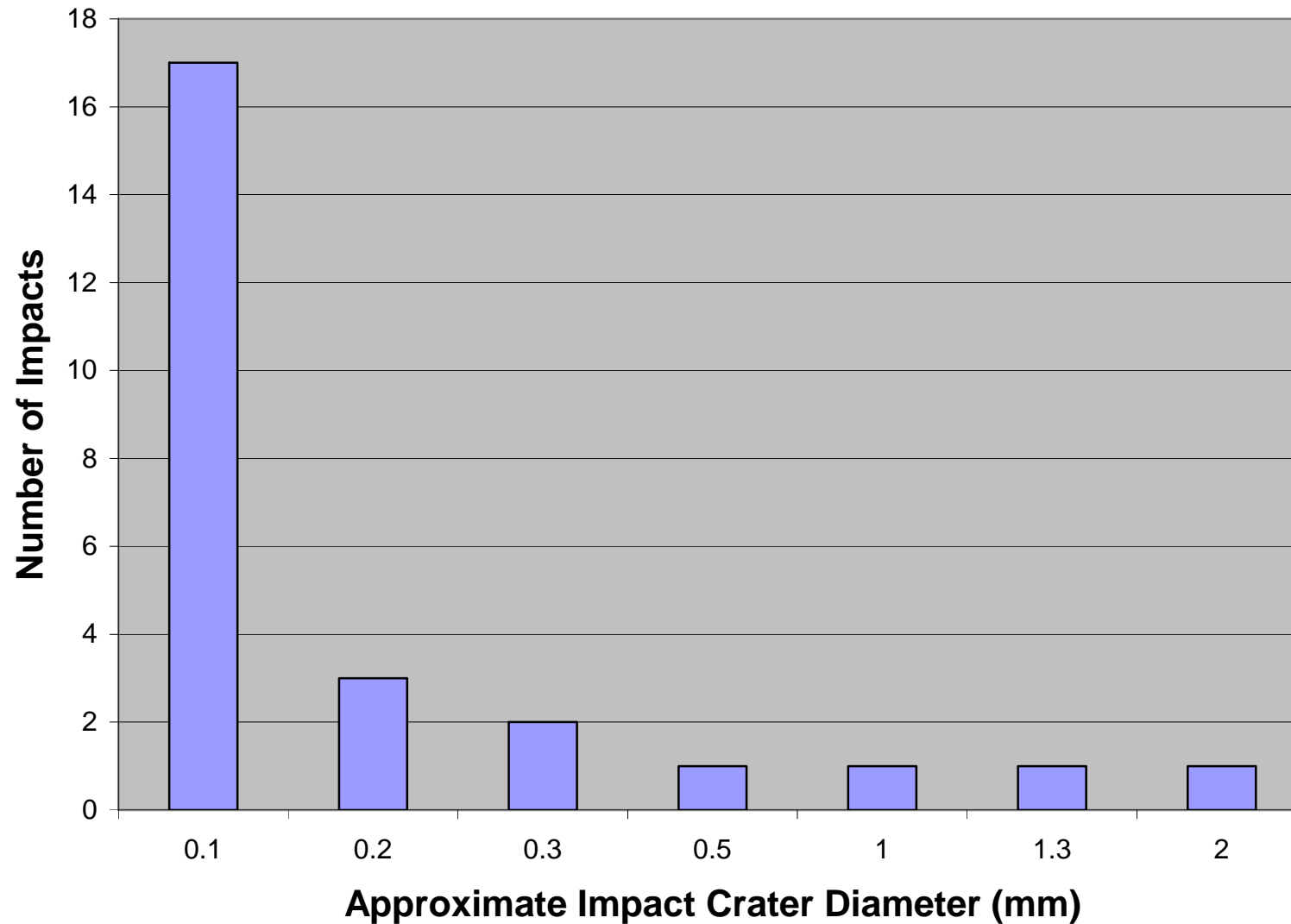
Plasma

ISS Plasma Contactor Units maintain floating potential between ± 40 V.

Meteoroid & Space Debris Impact



Distribution of Impacts on MISSE 3 and 4



Contamination



ISS assembly during MISSE-3 and MISSE-4 exposure

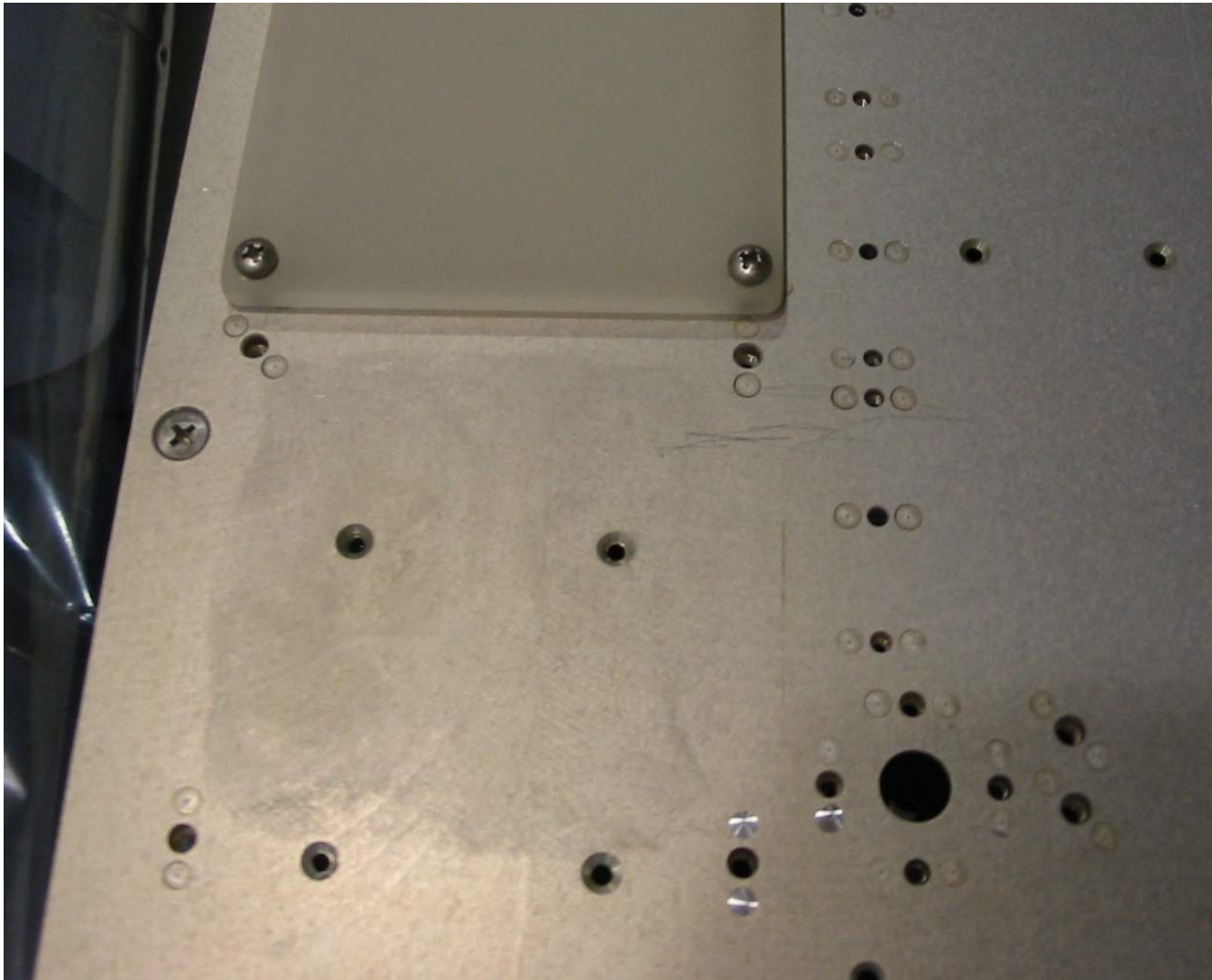
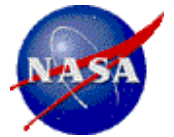
- STS-115 P3 / P4 Truss and Solar Array
- STS-116 P5 Truss
- STS-117 S3 / S4 Truss and Solar Array
- STS-118 S5 Truss and External Stowage Platform

Contamination on samples appeared to be minimal.

Some localized contamination was seen on baseplate.

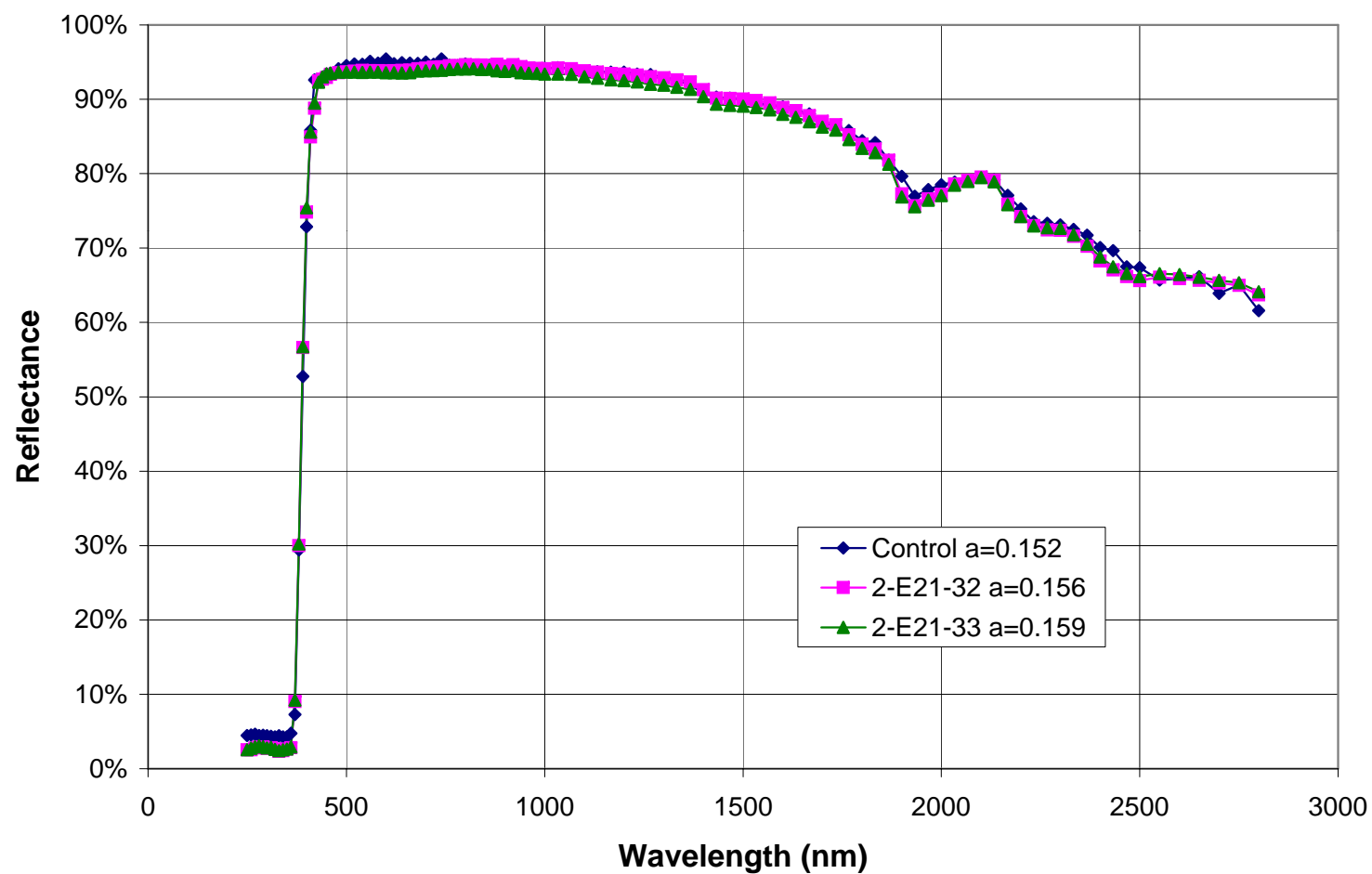
Ceramic white thermal control coatings have solar absorptances within 0.01 of pre-flight measurements.

Contamination





MISSE-3 Wake Side - AZ93 Thermal Control Coating



MISSE-3 and MISSE-4 Exposure Summary



**Nominal Ram-facing surfaces maximum fluence of atomic oxygen
<2.2 E+21 atoms/cm².**

**Solar exposures ranges
~1200 to 1700 ESH on ram sides
~700 to 900 ESH on wake sides**

Particulate radiation low, agrees with previous measurements at same altitude and inclination. Dose levels indicate significant increased shielding by ISS structure relative to MISSE-1 and MISSE-2.

Molecular contamination levels generally low, may be significant for certain materials.